Radar Mapping and l'recision Ranging of Mercury and Mars

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Radar ranging is useful for maintenance of the knowledge of the orbits of the inner planets, Mercury and Mars have not had precision ranging to a spacecraft since Mariner 10 and the Viking Landers respectively. New Discovery-class missions arc planned for Mars and arc being considered for Mercury. Thus the updating of the ephemerides of these planets is currently important. Valuable science can also result from updating these ephemerides. For example, the orbit of Mars is subject to significant perturbations from mainbelt asteroids, and thus presents the potential to measure selected large asteroid masses if enough data could bc accumulated, The orbit of Mercury is eccentric and deep in the solar gravitational WC]], thus providing a unique opportunity to test so-called "Parameterized Post-Newtonian" (PPN) metric generalizations of General Relativity (as well as non-metric theories insofar as they make predictions). The most interesting such tests of gravitational theories require the combination of the data sets from *all* the inner planets. Orbital effects accumulating as t^2 due to a possible time-variation of G can bc sought, as well as "Nordtvedt" effects duc to possible differences between inertial and gravitational masses, Radar ranging data can contribute strongly to such tests, particularly when "closure points" (the same topography covered on different dates) arc available.

Radar ranging also can bc used to derive the topography of the equatorial zones of the inner planets. The latitude coverage in any given time span is limited by the practical necessity of observing during the target planet's inferior conjunctions/oppositions. Radar observations can provide topography "profiles", statistical surface roughness, and also radar images within a fcw degrees of the subearth point, Goldstone/Very Large Array bistatic radar observations can image the whole disk of planets. Ncw delay-Doppler mapping techniques can also image the entire disks of planets, even for "overspread" targets (albeit with instantaneous north-south ambiguity) (Harmon *et al., 1992*; Jurgens *et al.*, 1994). Data from all of these radar techniques can bc applied to observing Martian surface properties relating to landing safety issues for MESUR, as was done for the Viking landers. During the 1995 Mars Opposition, additional opportunities exist for obtaining the data types described above at latitudes -25° N., similar to the 1980 and 1982 oppositions, with greater resolut ion and/or smaller radar "footprint".

Radar interferometry provides the capability to perform delay-l~opplcr imaging and topographic mapping without north-south ambiguity. Such experiments require multiple antennas and increase the data processing requirements greatly. Nevertheless, lunar topography (Shapiro *et* al., 1972) and Venus topography (Jurgens *et* al., 1980) have been mapped by using the interferometric technique, Extension of this technique to Mercury may bc valuable for planning of the Mercury Discovery-c]ass missions under consideration.

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